

CLAIMS

What is claimed is:

1. A composition comprising a phenanthroline derivative having
 5 Formula I, shown in Figure 1, wherein:
 R^1 and R^2 are the same or different at each occurrence and are
 selected from H, F, Cl, Br, alkyl, heteroalkyl, alkenyl, alkynyl,
 aryl, heteroaryl, $C_nH_aF_b$, $OC_nH_aF_b$, $C_6H_cF_d$, and $OC_6H_cF_d$;
 a, b, c, and d are 0 or an integer such that $a+b = 2n + 1$, and $c + d$
 10 $= 5$,
 n is an integer;
 x is 0 or an integer from 1 through 3;
 y is 0, 1 or 2;
 with the proviso that there is at least one substituent on an aromatic
 15 group selected from F, $C_nH_aF_b$, $OC_nH_aF_b$, $C_6H_cF_d$, and $OC_6H_cF_d$.
 2. The composition of Claim 1, wherein R^1 is selected from phenyl,
 substituted phenyl, biphenyl, substituted biphenyl, pyridyl, substituted
 pyridyl, bipyridyl, and substituted bipyridyl.
 3. The composition of Claim 2, wherein R^1 is selected from
 20 substituted phenyl, substituted biphenyl, substituted pyridyl, substituted
 bipyridyl having at least one substituent selected from alkyl, heteroalkyl,
 aryl, heteroaryl, arylalkylene, heteroarylalkylene, $C_nH_aF_b$, and $C_6H_cF_d$.
 4. The composition of Claim 1, wherein at least one R^1 is selected
 from substituted phenyl and substituted biphenyl having at least one
 25 substituent selected from F, $C_nH_aF_b$, $OC_nH_aF_b$, $C_6H_cF_d$, and $OC_6H_cF_d$.
 5. The composition of Claim 1, wherein the phenanthroline
 derivative is selected from Formulae I(b) through I(f) in Figure 3.
 6. A composition having a formula selected from Formula II(a) and
 Formula II(b) in Figure 2, wherein:
 30 R^1 and R^2 are the same or different at each occurrence and are
 selected from H, F, Cl, Br, alkyl, heteroalkyl, alkenyl, alkynyl,
 aryl, heteroaryl, $C_nH_aF_b$, $OC_nH_aF_b$, $C_6H_cF_d$, and $OC_6H_cF_d$
 R^3 is the same or different at each occurrence and is selected from
 a single bond and a group selected from alkylene,
 35 heteroalkylene, arylene, heteroarylene, arylenealkylene, and
 heteroarylenealkylene;
 Q is selected from a single bond and a multivalent group;
 m is an integer of at least 2;

n is an integer;

p is 0 or 1,; x is 0 or an integer from 1 through 3; and

y is 0, 1, or 2.

7. The composition of Claim 6 wherein Q is selected from a
5 hydrocarbon group with at least two points of attachment, selected from an
aliphatic group, a heteroaliphatic group, an aromatic group, and a
heteroaromatic group.

8. The composition of Claim 7 wherein Q is selected from alkylene
groups, heteroalkylene groups, alkenylene groups, heteroalkenylene
10 groups, alkynylene groups, and heteroalkynylene groups.

9. The composition of Claim 6 wherein Q is selected from single-
ring aromatic groups, multiple-ring aromatic groups, fused-ring aromatic
groups, single-ring heteroaromatic groups, multiple-ring aromatic groups,
fused-ring aromatic groups, arylamines, silanes and siloxanes.

15 10. The composition of Claim 6, wherein Q is selected from
Formulae III(a) through III(h) in Figure 4.

11. The composition of Claim 6, wherein R¹ is selected from
phenyl, substituted phenyl, biphenyl, substituted biphenyl, pyridyl,
substituted pyridyl, bipyridyl, and substituted bipyridyl.

20 12. The composition of Claim 11, wherein R¹ is selected from
substituted phenyl, substituted biphenyl, substituted pyridyl, and
substituted bipyridyl, having at least one substituent selected from alkyl,
heteroalkyl, aryl, heteroaryl, arylalkylene, heteroarylalkylene, F, C_nH_aF_b,
OC_nH_aF_b, C₆H_cF_d, and OC₆H_cF_d.

25 13. The composition of Claim 6, wherein at least one R¹ is selected
from substituted phenyl and substituted biphenyl having at least one
substituent selected from F, C_nH_aF_b, OC_nH_aF_b, C₆H_cF_d, and OC₆H_cF_d.

14. The composition of Claim 6, wherein R³ is selected from a
phenylene and a substituted phenylene.

30 15. The composition of Claim 14 having at least one substituent
selected from alkyl, heteroalkyl, aryl, heteroaryl, arylalkylene,
heteroarylalkylene, F, C_nH_aF_b, OC_nH_aF_b, C₆H_cF_d, and OC₆H_cF_d.

16. The composition of Claim 6, wherein R³ is selected from an
alkylene group having from 1 through 20 carbon atoms.

35 17. The composition of Claim 6, wherein there is at least one
substituent on an aromatic group selected from F, C_nH_aF_b, OC_nH_aF_b,
C₆H_cF_d, and OC₆H_cF_d.

18. An electronic device comprising at least one layer that comprises a phenanthroline derivative having Formula I, shown in Figure 1, wherein:

5 R^1 and R^2 are the same or different at each occurrence and are selected from H, F, Cl, Br, alkyl, heteroalkyl, alkenyl, alkynyl, aryl, heteroaryl, $C_nH_aF_b$, $OC_nH_aF_b$, $C_6H_cF_d$, and $OC_6H_cF_d$; a, b, c, and d are 0 or an integer such that $a+b = 2n + 1$, and $c + d = 5$;

n is an integer;

10 x is 0 or an integer from 1 through 3;

y is 0, 1 or 2;

with the proviso that there is at least one substituent on an aromatic group selected from F, $C_nH_aF_b$, $OC_nH_aF_b$, $C_6H_cF_d$, and $OC_6H_cF_d$.

15 19. The device of Claim 18, wherein R^1 is selected from phenyl, substituted phenyl, biphenyl, substituted biphenyl, pyridyl, substituted pyridyl, bipyridyl, and substituted bipyridyl.

20 20. The device of Claim 19, wherein R^1 is selected from substituted phenyl, substituted biphenyl, substituted pyridyl, substituted bipyridyl having at least one substituent selected from alkyl, heteroalkyl, aryl, heteroaryl, arylalkylene, heteroarylalkylene, $C_nH_aF_b$, and $C_6H_cF_d$.

21. The device of Claim 18, wherein at least one R^1 is selected from substituted phenyl and substituted biphenyl having at least one substituent selected from F, $C_nH_aF_b$, $OC_nH_aF_b$, $C_6H_cF_d$, and $OC_6H_cF_d$.

25 22. The electronic device of Claim 18, wherein the phenanthroline derivative is selected from Formulae I(a) through I(i) in Figure 3.

23. An electronic device comprising at least one layer that comprises a composition having a formula selected from Formula II(a) and Formula II(b) in Figure 2, wherein:

30 R^1 and R^2 are the same or different at each occurrence and are selected from H, F, Cl, Br, alkyl, heteroalkyl, alkenyl, alkynyl, aryl, heteroaryl, $C_nH_aF_b$, $OC_nH_aF_b$, $C_6H_cF_d$, and $OC_6H_cF_d$, R^3 is the same or different at each occurrence and is selected from a single bond and a group selected from alkylene, heteroalkylene, arylene, heteroarylene, arylenealkylene, and heteroarylenealkylene;

35 Q is selected from a single bond and a multivalent group;

m is an integer equal to at least 2;

n is an integer;

p is 0 or 1;
x is 0 or an integer from 1 through 3; and
y is 0, 1, or 2.

24. The device of Claim 23 wherein Q is selected from a
5 hydrocarbon group with at least two points of attachment, selected from an
aliphatic group, a heteroaliphatic group, an aromatic group, and a
heteroaromatic group.

25. The device of Claim 24 wherein Q is selected from alkylene
groups, heteroalkylene groups, alkenylene groups, heteroalkenylene
10 groups, alkynylene groups, and heteroalkynylene groups.

26. The device of Claim 23 wherein Q is selected from single-ring
aromatic groups, multiple-ring aromatic groups, fused-ring aromatic
groups, single-ring heteroaromatic groups, multiple-ring aromatic groups,
fused-ring aromatic groups, arylamines, silanes and siloxanes.

15 27. The device of Claim 23, wherein Q is selected from Formulae
III(a) through III(h) in Figure 4.

28. The device of Claim 23, wherein R¹ is selected from phenyl,
substituted phenyl, biphenyl, substituted biphenyl, pyridyl, substituted
pyridyl, bipyridyl, and substituted bipyridyl.

20 29. The device of Claim 28, wherein R¹ is selected from substituted
phenyl, substituted biphenyl, substituted pyridyl, and substituted bipyridyl,
having at least one substituent selected from alkyl, heteroalkyl, aryl,
heteroaryl, arylalkylene, heteroarylalkylene, F, C_nH_aF_b, OC_nH_aF_b,
C₆H_cF_d, and OC₆H_cF_d.

25 30. The device of Claim 23, wherein at least one R¹ is selected
from substituted phenyl and substituted biphenyl having at least one
substituent selected from F, C_nH_aF_b, OC_nH_aF_b, C₆H_cF_d, and OC₆H_cF_d.

31. The device of Claim 23, wherein R³ is selected from a
phenylene and a substituted phenylene.

30 32. The device of Claim 31 having at least one substituent selected
from alkyl, heteroalkyl, aryl, heteroaryl, arylalkylene, heteroarylalkylene, F,
C_nH_aF_b, OC_nH_aF_b, C₆H_cF_d, and OC₆H_cF_d.

33. The device of Claim 23, wherein R³ is selected from an
alkylene group having from 1 through 20 carbon atoms.

35 34. The device of Claim 23, wherein there is at least one
substituent on an aromatic group selected from F, C_nH_aF_b, OC_nH_aF_b,
C₆H_cF_d, and OC₆H_cF_d.

35. A composition comprising a phenanthroline derivative having Formula II, shown in Figure 2, wherein:

R^2 and R^3 are the same or different at each occurrence and are selected from H, alkyl, heteroalkyl, aryl, heteroaryl, $C_nH_aF_b$,

5 $OC_nH_aF_b$, $C_6H_cF_d$, and $OC_6H_cF_d$;

a, b, c, and d are integers such that $a+b = 2n + 1$, and $c + d = 5$,

x is 0 or an integer from 1 through 3;

y is 0, 1 or 2;

10 with the proviso that there is at least one substituent on an aromatic group selected from F, $C_nH_aF_b$, $OC_nH_aF_b$, $C_6H_cF_d$, and $OC_6H_cF_d$.

36. A composition selected from Formula II(a) in Figure 2, wherein:

Q is selected from a single bond and a multivalent group;

m is an integer from 2 through 10;

15 R^3 is the same or different at each occurrence and is selected from a single bond and a group selected from alkylene, heteroalkylene, arylene, heteroarylene, arylenealkylene, and heteroarylenealkylene;

R^1 and R^2 are the same or different at each occurrence and are selected from H, alkyl, heteroalkyl, aryl, heteroaryl, $C_nH_aF_b$,

20 $OC_nH_aF_b$, $C_6H_cF_d$, and $OC_6H_cF_d$

y is 0, 1 or 2.

a, b, c, and d are integers such that $a+b = 2n + 1$, and $c + d = 5$,

37. The composition of Claim 36 wherein Q is selected from Formulae III(a) through III(h) in Figure 4.

25 38. An electronic device comprising at least one layer comprising the composition of any one of Claims 35 through 37.

39. An electronic device of Claims 35 through 37, wherein the device is a light-emitting diode, light-emitting electrochemical cell, or a photodetector.